SHIPBOARD ELECTRICAL CABLE TEST

1. SCOPE

1.1 Intent. This specification provides guidance and requirements for conductor and insulation resistance tests of shipboard electrical cables.

2. REFERENCES

COAST GUARD DRAWINGS

None.

COAST GUARD PUBLICATIONS

None.

OTHER REFERENCES

MIL-DTL-17, May 2011, Cables, Radio Frequency, Flexible and Semi-Rigid, General Specifications for

3. REQUIREMENTS

3.1 General. Test all newly installed and modified electric cables in accordance with paragraphs 3.2 through 3.4 below before energizing the associated circuits. Record test data obtained during performance of sections 3.2 through 3.4 below, including circuit cable and lead identification numbers. Submit CFR.

3.2 Conductor Resistance Test.

3.2.1 Unless specified in the work item, conductor resistance measurements are not required for conductors smaller than 150 MCM. Measure the resistance of each conductor (including compression lugs) after installation, but before connection to studs or other terminations. Record the conductor size, length, resistance, and identifier for each measurement taken.

3.2.2 Take measurements with a four wire micro-ohmmeter or other precision low resistance measuring device. To facilitate test performance, a pair of conductors in the same cable may be temporarily electrically connected together at one end. Record the resistance of each conductor as half the measured value.

3.2.3 The resistance of each conductor shall be within 2% of the average and within 5% of the value shown in the Table 1 below. Conductors not listed in Table 1 nor the work item need only meet the 2% of average criteria. For temperatures other than those shown in Table 1, use the formula below to temperature correct the conductor resistance for comparison with the 20ºC column:

$$R_{20} = \frac{R_T}{1 + 0.00393\left(T - 20\right)}$$

where R_{20} is the corrected insulation resistance
R_T is the uncorrected insulation resistance
T is the conductor temperature (°C)

TABLE 1 – MAXIMUM ACCEPTABLE CONDUCTOR RESISTANCE

Nominal Conductor (MCM)	Conductor Area (MCM)	Number of Strands	DC Resistance (μΩ/ft)				
			10ºC	15ºC	20ºC	25ºC	30ºC
150	167.8	61	63.5	64.8	66.1	67.4	70.0
200	211.6	61	49.5	50.5	51.5	52.5	54.6
300	300.0	91	35.5	36.2	37.0	37.7	39.2
400	413.6	127	25.7	26.2	26.8	27.3	28.4
500	500.0	127	22.0	22.5	22.9	23.4	24.3
650	650.0	127	16.0	16.3	16.7	17.0	17.7
800	800.0	127	13.0	13.3	13.5	13.8	14.3

3.3 Insulation Resistance Test.

3.3.1 Accomplish insulation resistance tests of all new and disturbed electric cables using a direct current megohmmeter (e.g., Megger®). Apply test voltage between each conductor and ground, as well as between each pair of conductors in the same cable. For shielded cables apply test voltage to the shield in lieu of ground and limit conductor-to-conductor testing to those within the same shield. Test voltage shall be as shown in Table 2 below, except that coaxial cables shall be tested at 500 VDC and power cables at no less than 500 VDC unless connected to equipment not rated for such voltage. Do not test systems with voltage sensitive electronics unless such components are disconnected or completely isolated by a disconnect switch or removed fuses.

TABLE 2 – INSULATION RESISTANCE TEST VOLTAGES

Operating Voltage (VDC or VAC)	Test Voltage (VDC)
51-150	100 or 150
151-250	250
251-500	500

Operating Voltage (VDC or VAC)	Test Voltage (VDC)
501-1000	1000
1001-2500	2000 or 2500
2501-6600	5000

3.3.2 The minimum acceptance readings of conductors to ground and between conductors shall be as shown in Table 3 below. When only cable insulation resistance is being measured (no load or control equipment in the circuit under test), the resistivity shall be greater than the value shown in Table 3 for the cable temperature.

3.3.2.1 Resistivity is calculated by multiplying the effective conductor length under test by the measured resistance, uncorrected for temperature.

3.3.2.2 Effective length is computed by adding the length of all conductors to which test voltage is applied during the insulation resistance measurement.

3.3.2.3 For cases where conductor temperature is between table values and the measured resistivity is not greater than the tabulated value for the next lowest temperature, logarithmic interpolation may be used to calculate a lower acceptable minimum insulation resistance.

TABLE 3 – MINIMUM ACCEPTABLE INSULATION RESISTANCE

Circuit	Total Resistance (MΩ)	Resistivity (MΩ-ft)		
		40ºF	70ºF	140ºF
Lighting	0.5	5500	920	95
Power	1.0	5500	920	95
Instrumentation & Control	1.0	5500	920	95
Audio & Telephone	0.05	2200	380	40
Degaussing	0.1			
Coaxial (polyethylene or polytetrafluoroethylene [Teflon] dielectric)	4,000		4,000,000	
Coaxial (synthetic rubber dielectric)	1,000			
Coaxial (magnesium oxide dielectric)	10,000			

3.4 Coaxial Cable Tests.

3.4.1 In accordance with the procedures of MIL-DTL-17, accomplish the following transmission line tests of all new and disturbed coaxial cables (including heliax, but not audio or video cables) after installation:

- Attenuation
- Voltage standing wave ratio (VSWR)

3.4.2 Attenuation and VSWR data shall meet applicable MIL-DTL-17 or cable manufacturer's specifications.

4. NOTES

4.1 The insulation resistance test of Section 3.3 above is intended to be performed with the conductor under test disconnected at both ends. To avoid unnecessary disconnection of conductors, such testing may also be performed with cables connected to equipment at one or both ends under the following conditions:

4.1.1 The equipment is a switch, fuse block, bus link, circuit breaker, or other device than can be positioned to open all poles.

4.1.2 The equipment contains internal windings that are connected phase to phase or positive to negative, such as a solenoid, motor, transformer, generator, or heater. In such case only line to ground insulation resistance readings will be meaningful.

4.1.3 If the measured insulation resistance is not greater than the minimum acceptable value, then disconnection of leads will be necessary to determine whether the problem is in the cable or elsewhere.

4.2 A time domain reflectometer (TDR) cable tester may be useful in determining the physical location of a discontinuity in a long cable run. Such discontinuities may be the result of broken conductor strands (high conductor resistance) or grounds. TDR testers are most often used to check coaxial cables and are generally carried on the tool inventory of most Electronic Support Units and Detachments.